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X.—*On the Invertebrate Animals of the Baltic.* By Prof. Karl Möbius.*

Faunistically the Baltic is sharply divided into an eastern and a western basin. The western basin is separated from the Kattegat by the Danish islands. I do not include the Belts and the Œresund in the western basin when I speak of the fauna of the latter. The eastern basin meets the western one in the meridian of the west coast of the Isle of Rügen.

Of the 241 invertebrate animals catalogued, 216 species have been found in the western, and hitherto only 69 in the eastern basin.

Besides those mentioned, Acarina, Ostracoda, Infusoria, and Rhizopoda exist in the Baltic; but their enumeration must be postponed until the species have been determined with more certainty, for which purpose further investigations are necessary.

Among the Infusoria, however, I will refer to *Peridinium tripos*, Müll.†, which appears in great abundance during the summer and autumn in the bay of Kiel as a luminous animal, and is of importance as food for Copepoda and the swarming embryos of other Invertebrata.

* Translated by W. S. Dallas, F.L.S., from the concluding remarks appended by the author to the list of the Invertebrata of the Baltic, prepared by him with the assistance of Profs. K. Kupffer, E. Häckel, W. Schmidt, and of Dr. Bütschli, and published as part of the report on the scientific results of the expedition of the steamship 'Pommerania' in 1871 (pp. 138–141).

† Ehrenberg, 'Infusionsthierchen,' p. 255, pl. 22. fig. 18.

The shell-bearing Mollusca, to which the second volume of the 'Fauna der Kieler Bucht' is devoted, are particularly well fitted for comparisons between animals of the same species inhabiting both the North Sea and the Baltic. In all the shells are lighter than in specimens of the same dimensions from the North Sea*. Stunting occurs also in the other classes of animals. Thus at Kiel the fore part of the body of *Temora longicornis* is, on the average, only 1 millim. in length, whilst it becomes 2 millims. long in individuals from Arendal. At Kiel *Pectinaria belgica* only attains a thickness of 5 millims. in front; at Arendal this worm becomes so large that it attains a transverse diameter of 12 millims at its anterior end. Another worm, *Travisia Forbesii*, becomes 15 millims. long, and 3–4 millims. thick at Warnemunde, and 26 millims. long and 7 millims. thick (according to Rathke) on the Norwegian coast.

In the eastern basin of the Baltic the animals become far more stunted than in the western. Near Kiel *Mytilus edulis* becomes 8–9 centims. long; in the eastern basin (*e.g.* on the Stolper Bank, near Gotland, near Dularö) this mollusk only attains a length of 3–4 centims. *Mya arenaria*, *Tellina balthica*, and *Cardium edule* differ less in the eastern basin, as far as Gotland, from the individuals of the same species in the western basin, than the individuals of *Mytilus* in the two basins differ from each other. This phenomenon is due to the fact that even in the western basin these mollusca are surrounded for the greater part of the year with but slightly salt water, as they inhabit the smaller depths.

In *Mytilus edulis* and *Tellina balthica*, of the eastern basin, the calcareous layers of the shell are extraordinarily thin. After the death of the mollusk, the calcareous mass of the shell seems to disappear very speedily; for among the rocks of eastern Sweden, between Sweden and Gotland, and in the Calmarsund, we found in the clayey mud of the sea-bottom a great many cuticular membranes of *Mytilus edulis* and *Tellina balthica* most perfectly preserved. The two brown membranes were often united at the dorsal margin by the ligament, as in the perfect shell. If a sea-bottom of this kind were upheaved these cuticular shells in the clay would appear just like thin impressions of *Posidoniæ*, with all the curvatures and deformations by pressure with which we are acquainted in those fossils of the fine shales of secondary formations; and we should fall into a great error if we were to conclude from these bendings of the cuticular shells that the strata of clay had been bent after they were laid dry.

* See 'Fauna der Kieler Bucht,' Bd. ii. p. xvii.

By far the greater number of the Invertebrata of the Baltic are also inhabitants of the North Atlantic Ocean. Of many of them we know that they are spread into the icy polar sea, and as far as the African coast. With regard to the shell-bearing mollusca, this was demonstrated in detail in the 'Fauna der Kieler Bucht.' This wide distribution of the Baltic animals, their ability to live in warm, temperate, and cold seas, becomes intelligible when we have made ourselves acquainted with the temperatures which they have to endure in the Baltic. In the physico-chemical section of this Report it is shown by a table (xxxii.), founded upon three years' observations by Dr. H. A. Meyer, that the differences of temperature in the superficial layer rose to 14°·9–20° (=26°·8–36° F.), attained 13°·3–17°·3 (=23°·9–31°·14 F.) at 5 fathoms, and even at a depth of 16 fathoms still amounted to 9°·2–12°·2 (=16°·56–21°·96 F.). In all the strata of the water, even in the deepest, at the coldest season, the animals of the Baltic have to endure a temperature which sinks to the freezing-point of salt water, therefore below zero (=32° F.). In summer and autumn, on the contrary, they are exposed to a pretty high temperature. The different temperatures which the individuals of a species experience in the course of a year in the Baltic are undergone *at the same time* by other individuals of the same species which live in the Mediterranean, the North Sea, and the north polar sea. *The Baltic contains only a selection of such Atlantic and Polar animals as are capable of supporting great differences of temperature.* For this reason they may be called *eurythermal** animals, in contradistinction to those animals which thrive only in warm or cold and tolerably constant temperatures, such as the tropical and exclusively arctic marine animals, both of which may on this account be denominated *stenothermal*† animals.

All the marine animals of the Baltic have further the faculty of living in sea-water containing a variable amount of salt; those Baltic animals which also occur in the Mediterranean can bear a larger amount of salt than the Atlantic ocean contains. This faculty of the Baltic animals is by no means indicated by calling them brackish-water animals; on the contrary, this expression carries our thoughts away from one of their most remarkable peculiarities; for animals which can live not only in *slightly* but also in *strongly* salt water are not brackish-water, but *euryhaline*‡ animals.

A very perfectly euryhaline animal is *Hydrobia ulvæ*.

* From εὐρύς, wide, and θερμός, heat.
† From στενός, narrow, and θερμός, heat.
‡ From εὐρύς, wide, and ἅλς, salt.

This Gasteropod becomes developed in the slightly salt water near Gotland to the same size as in more than normally salt lakes on the shore of the North Sea.

Because the Baltic animals are eurythermal and euryhaline they are capable of living both at small and great depths and of maintaining their ground throughout long geological periods.

Among the animals catalogued there is only one true brackish-water animal, namely *Cordylophora lacustris*, a polype which lives only in very slightly salt water, and perishes both in fresh water and in water containing a larger amount of salt*.

Besides this brackish-water animal and the euryhaline animals, a number of freshwater animals live in the eastern basin. These are such as can bear slightly salt water. Nature has not succeeded in habituating them to the larger amounts of salt in the western basin, although probably she makes fresh attempts every year to diffuse freshwater animals from the mouths of rivers and brackish-water bays further into the sea. The pioneers constantly sent out, however, have been unable to force their way into the salter region. Such miscarriages of Nature in her constant forward march must render us very cautious in estimating the value of experiments made in aquaria for the purpose of habituating freshwater animals to salt water and marine animals to fresh water. I refer here especially to the recent experiments of Plateau upon *Asellus aquaticus* and some other animals†.

The number of species diminishes suddenly when we pass from the shallow and more saline western basin into the deeper and less saline eastern basin. We found most of the species of the latter at depths from 0–20 fathoms; they became fewer at 20–50 fathoms, and very few from 50–95 fathoms.

The following animals are inhabitants of the greater depths of the eastern basin:—

Astarte borealis	down to	46	fathoms.
Tellina balthica	”	49	”
Cuma Rathkei	”	49	”
Idotea entomon	”	60	”
Astemma rufifrons	”	50	”
Nemertes gesserensis	”	60	”
Halicryptus spinulosus	”	50	”
Scoloplos armiger	”	46	”
Terebellides Strömii	”	47	”
Polynoë cirrata	”	95	”

* See p. 100 of the Report, and also E. Schultze, ‘Bau und Entwicklung von *Cordylophora lacustris*,’ 1871, pp. 43–48.

† Mém. Acad. Belg. 1870, and Ann. & Mag. Nat. Hist. ser. 4. vol. vii. 1871, p. 362.

Thus the Crustacea and Vermes go deepest. Bivalve mollusca were no longer found in the great depths, although organic substances still existed there, as is shown by Dr. Behrens from his investigations of samples from the bottom. As the bivalve mollusca are among those important animals which are capable of converting dead organic substances of the sea-bottom into living animal matter, the number of carnivorous animals must also be diminished where they are wanting, unless other mud-eaters carry out the business of the first preparation of flesh in their stead.

Our knowledge of the physico-chemical conditions of the greater depths is not sufficient to explain satisfactorily the disappearance of the animals. Besides the small amount of salt and the persistently low temperature, one of the causes of the impoverishment of the fauna in the greater depths of the eastern basin of the Baltic must be sought in the wêakening of the currents which assist the change of gases and carry food with them.

The ten species which were found at depths of 46–95 fathoms are all inhabitants of higher regions. In general, the animals of the eastern basin of the Baltic, as may be seen from the list of their localities, accommodate themselves to various depths and to the most various conditions of the bottom. They possess a greater capacity of adaptation to differences in the amount of salt, in temperature, depth, and bottom, than those species which occur only in the western basin. This very pliable nature has given them the predominance over the whole eastern region; and here, therefore, they can develop into enormous multitudes of individuals without having to maintain a contest for their dwelling-place and nourishment with fresh immigrants from the west.

The species which occur in particular abundance are the following:—*Hydrobia ulvæ*, *Mytilus edulis*, *Tellina balthica*, *Cardium edule*, *Palæmon squilla*, *Cuma Rathkei*, *Mysis spinulosa*, *M. vulgaris*, *Gammarus locusta*, *Pontoporeia femorata*, *Idotea entomon*, *I. tricuspidata*, *Jæra marina*, *Temora longicornis*, *Polynoë cirrata*, *Scoloplos armiger*, *Nephthys ciliata*, *Nereis diversicolor*, *Terebellides Strömii*, *Halicryptus spinulosus*, *Membranipora pilosa*, *Alcyonidium mytili*, and *Medusa aurita*.

The simultaneous production of many individuals of the same species at the same place is of importance for the nutrition of the edible fishes. As soon as these have found the dwelling-place of a great multitude of individuals of bivalve mollusca, worms, crustacea, or other eatable animals, they can feed themselves with ease. This also explains why we often find in the stomachs of fishes many animals of the same species.

A great quantity of uniform nourishment in a region is therefore favourable to the growth and fertility of fishes ; and it is this that collects the fishes in particular places in such quantities that a profitable fishery can be carried on there.

The value which great quantities of animals of the same species may attain as fish-nourishment may be shown by an example. The oldest fishermen of Ellerbeck can number no year in which they took so many herrings in Kiel harbour as in the winter and spring of 1872. According to the estimates of MM. F. Holm and J. Schmidt, fish-dealers of Kiel, for three weeks, especially in January and February, 3000 *walls* of herrings (mixed with sprats) were taken daily. Each *wall* consists of 80 fishes. The contents of the stomachs of the herrings captured consisted chiefly of a small crustacean, *Temora longicornis*, the fore body of which is only 1 millim. in length. Here and there among them there was another equally small Copepod, *Dias longiremis*. Very rarely some larger crustacea (*Mysis flexuosa*, *Idotea tricuspidata*, or *Gammarus locusta*) were intermixed with the food. Very often nothing but *Temora longicornis* was to be observed in five or six samples of the contents of the stomach when examined microscopically. These little crustacea filled the stomachs of the herrings as a stiff paste of a pale reddish colour ; in the intestines there was a soft red excrement, in which the legs, antennæ, and spermatophora [egg-sacs ?] of the same Copepod were still recognizable. On the 28th of February I took from the stomach of a female herring, of 25 centims. length, 1·5 cubic centim. of the above-mentioned stiff *Temora*-paste, and placed it in spirits, in order to undertake subsequently an estimate of the number of animals eaten. The whole volume of the mass diluted with spirits amounted to 9 cubic centims. It was shaken up in the bottle in order to diffuse the crustaceans equally, and 1 cubic centim. of it was taken out. By counting this in portions I found in it 2130 specimens of *Temora longicornis* ; this number multiplied by 9 gives 19,170 Copepods in the contents of the stomach, consisting of 1·5 cubic centim. of *Temora*-paste. This gives 12,780 specimens to 1 cubic centim. of the contents of the stomach.

A female herring, with a particularly full stomach, opened on the 24th of February, contained 4 cubic centims. of *Temora*-paste, three specimens of *Mysis flexuosa*, and one *Idotea tricuspidata*. The *Temora*-paste was diluted with spirit until the whole mass made 19 cubic centims. Of this 1 cubic centim. was poured off after the Copepods had been uniformly diffused by shaking the bottle. At my request, Dr. Bütschli counted the animals existing in it and found 3205 specimens.

$3205 \times 19 = 60{,}895$ was therefore the number of the Copepods devoured. 1 cubic centim. consequently contained 15,223 specimens. Counting the two ascertained numbers together and dividing them by two, we obtain 14,000 specimens as the average number in 1 cubic centim. of *Temora*-paste.

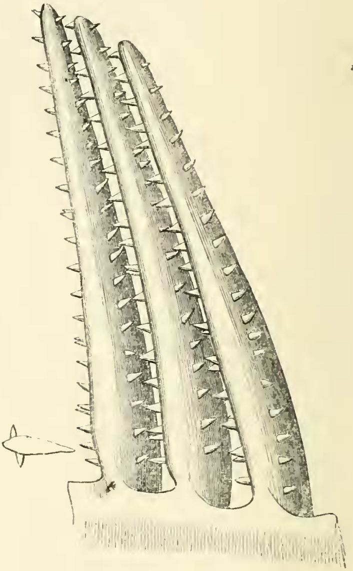
I did not find *Temora*-paste in the stomach of every herring or sprat that I opened, and in many only 1, or 0·75, or 0·5 cub. centim. But if we consider that those specimens whose stomachs contained from 1 to 4 cubic centims. of *Temora*-paste were taken quite at random from a great quantity of freshly caught animals, we shall certainly not go too far if we assume that every herring caught in Kiel Harbour had devoured 10,000 individuals of *Temora* during its sojourn there. Then, to the take of one day, of 3000 "wall," each of 80 fish, we get $3000 \times 80 \times 10{,}000 = 2400$ millions of individuals of *Temora longicornis*, and to the take of three weeks 43,200 millions of these little crustaceans.

That *Temora longicornis* existed in great abundance in Kiel Harbour at the time of the productive herring-fishery, was also proved by fishing with fine surface-nets. It was easy to collect many thousands of these animals. In herrings which had been taken near Eckernförde I also found many of them.

For the capture of Copepoda and other small swimming animals the herring possesses an excellent arrangement—we might say, a narrow-meshed *lobster-pot*, to which its mouth forms the entrance. This pot consists of the four branchial arches on each side, and of a close series of teeth on each arch. In herrings 20–23 centims. in length these teeth are of the following lengths:—on the first branchial arch 7–10 millims., on the second 3–4 millims., on the third 2–3 millims., and on the fourth 1·5–2 millims.; and they stand so close together that there are two teeth at least in a space of 1 millim. As these teeth are biconvex, the passages between them are much narrower than ½ millim. In the neighbourhood of the inner margin of each tooth, or that turned towards the cavity of the mouth, there stand two rows of *spines*—one row on the anterior, the other on the posterior surface of the tooth. These spines are from 0·2–0·3 millim. from each other. As the anterior row of spines stands a little nearer the inner edge of the tooth than the posterior row, the anterior spines of each tooth overreach the posterior spines of that preceding it. The spines of neighbouring teeth also frequently push in between one another. The narrow-spaced latticework which is thus produced allows the passage of the water which is to flow over the branchial lamellæ; but small animals (down to 0·2 and 0·1 millim. in diameter) which get into the mouth of the herring with the water are separated from it by this branchial basket, and accumulated at the back of the buccal cavity so as to be swallowed (*see* woodcut).

The branchial basket is constructed in the sprat exactly as in the herring.

In most other fishes which occur in abundance in Kiel Bay, such as *Belone rostrata*, *Zoarces viviparus*, *Anguilla fluviatilis*, *Platessa vulgaris*, *P. flesus*, *Gadus morrhua*, *Gasterosteus aculeatus*, and *Gasterosteus spinachia*, the teeth of the branchial arches are shorter and further apart than in *Clupea harengus* and *C. sprattus*. These fishes, therefore, cannot be competitors for food with the herrings and sprats. And that they are not so is proved by the contents of their stomachs, which usually consists of Mollusca and moderate-sized Crustacea (*Gammarus locusta*, *Mysis spinulosa*, and *Palæmon squilla*) or of small fishes, which they must seek chiefly at the bottom.



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Three teeth of the second branchial arch of the right side, from a herring 23 centims. long. Inside view from the cavity of the mouth, and so that the hinder side of the teeth may also be seen. The two rows of spines stand at unequal distances from the inner margin of the tooth, as shown by the annexed outline of a cross section of a tooth.

The mackerel (*Scomber scombrus*) alone is furnished with a branchial basket almost as close as that of the herring. As in the herring there are long teeth on their outer branchial arches; in a small mackerel, 18 centims. long, the longest were 8 millims. long, and 0·8 millim. from each other. At the sides also these teeth are furnished with spines, which are even longer and thinner than in the herring. The following three branchial arches of the mackerel, however, bear no long teeth, but an outer and inner series of tubercles with spines. By means of this latticework of teeth and spines the mackerel, like the herring, can easily filter great masses of Copepods from the water. According to A. Boeckh (Forhandl. Vid. Selsk. Christ. 1864, p. 227), the autumn mackerel on the Norwegian coast become fattened by abundant Copepod nourishment. On the east coast of Schleswig and Holstein the mackerel appears in considerable quantities only from the beginning of July to the end of September; from autumn to spring therefore, when the shoals of sprats and herrings appear here, the mackerel does not deprive them of any of their best food.

Where multitudes of food-animals occur, there also, as a general rule, multitudes of fishes collect. The herrings pursue the Copepods; and the cod (*Gadus morrhua*) follow the herrings. For a long time there had not been so many large cod taken between the fortress of Friedrichsort and the village of Labö as in the winter of 1871–72, when the herrings were so plentiful.

For carrying on the fishery, such a gathering together of great shoals of fishes belonging to the same species is of great value. Social animals of the same kind lead a similar life. They seek their food in common, become sexually mature at the same time, and collect, for the purpose of spawning, at definite spots. Thus the fisherman finds them at certain times in great numbers together, and can reckon beforehand on making a good haul with properly designed instruments of capture. But where many different species live, the fisherman cannot take an equal weight of fish with the same amount of labour, even when the sum of all the individuals in the same space is as great as the number of individuals of a single species, because each different species has a different nature, and consequently must be circumvented in a different manner. Hence, whilst the rich southern fish-fauna breaks up the work of the fishing-population and renders it less remunerative, the northern fish-fauna, which, although poorer in species, is rich in individuals, leads to a powerful and remunerative concentration of the business of fishery.

XI.—*On some new Species of* Stromatopora. By H. Alleyne Nicholson, M.D., D.Sc., F.R.S.E., &c., Professor of Natural History in University College, Toronto.

[Plate IV.]

The affinities of the singular genus *Stromatopora* have always been more or less uncertain, though there has been a general